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The health influence on returns to education in Brazil: A nonlinear approach

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Abstract

This paper investigates the returns to education in terms of individuals' health in Brazil. We use the Heckman procedure (1979) and a nonlinear model that allows the consideration of the existence of increasing returns. The study employs microdata from *National Survey by Household Sample* for 2003 and 2008. The health status is measured by self-assessment of individuals. We determine that the rate of returns decreases until the fourth and fifth years of schooling, that is, until the completion of primary education when increasing returns start. The evidence also indicates that the rate of return to education is lower for individuals in poor health; for people with 15 or more years of schooling, the rate of return is 10–14.5% lower for those who are unhealthy.

JEL classification: I1; I2; J2

Keywords: Return to education; Health; Nonlinear model

Resumo

O artigo investiga o efeito do estado de saúde individual na taxa de retorno da educação. O método empregado consiste em um modelo não linear, que permite a existência de retornos crescentes, e no procedimento de Heckman (1979). O estado de saúde é mensurado pela autoavaliação dos indivíduos. Com base nos dados da PNAD de 2003 e 2008, é encontrado que a taxa de retorno da educação decresce até o quarto e quinto ano de escolaridade, isso é, o retorno se torna crescente apenas a partir da conclusão das séries iniciais do ensino fundamental. Os resultados também apontam que a taxa de retorno é inferior para indivíduos que não referiram uma boa saúde; para indivíduos com 15 ou mais anos de escolaridade, a taxa de retorno é de 10% a 14.5% menor para indivíduos não saudáveis.
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Palavras-chave: Retorno da educação; Saúde; Modelo não linear

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1. Introduction

The literature reviewed shows that there is a close relationship between health status and socioeconomic variables, especially education and income. This relationship has been found in different countries and various measures of health have confirmed these findings. In explaining this relationship, Grossman (2000) argues that healthy people have advantage in obtaining additional years of schooling and knowledge quality. Hence, individuals in poor health miss more days of school and they learn less during the school year.

Some studies have shown empirical evidence of this relationship by addressing the effect of low birth weight on adult outcomes in twins (Black et al., 2007; Oreopoulos et al., 2008), individual shocks *in utero* (Almond, 2006; Almond et al., 2009) and early childhood nutrition problems (Maluccio et al., 2009; Khanam, 2014).

Other important aspect is that better health is associated with higher labor productivity and time available to work, which are essential factors in the labor market and, therefore, income. Healthier people tend to have higher labor productivity due to their greater physical energy and mental clearness, besides having a greater investment in human capital, the main driver of productivity (Bloom and Canning, 2000). Furthermore, Smith (1999) showed that poor health is associated with lower income and fewer accumulated assets because people with poor health have increased medical expenses and limitations on working, so healthier people can work for more hours in a week and more weeks in a year. Bloom and Canning (2000, p. 1209) conclude that “poor health is more than just a consequence of low income; it is also one of its fundamental causes”.

The literature has several studies of the relationship between health status with education and income, however, estimates of return to education that include health status, like this one, are limited. Although higher education is commonly related with higher wages, the returns to education may differ for different groups. The literature usually breaks down the returns by gender (Psacharopoulos and Patrinos, 2004; Mendolicchio and Rhein, 2014; Daoud, 2005), race (Mwabu and Schultz, 1996) and location (Suliano and Siqueira, 2012). There are few studies that have investigated returns to education across health groups. It is well known that the average schooling, average hourly wage, labor productivity and availability for work differ between health and unhealthy individuals. Likewise, the rate of returns might also differ by health status, as found for individuals with disabilities and poor health (Lamichhane and Sawada, 2013; Lamichhane and Watanabe, 2015; Hollenbeck and Kimmel, 2001). In specific for developing countries, to our knowledge, there is no study that analyzes the difference of return to education in terms of individuals’ health (good and poor health).

In this paper, we investigate whether the returns to education change in the context of poor health and the year of schooling for which the difference intensifies. Specifically, we examine the influences of health status on the rate of return to education. The remainder of this paper is organized as follows: Section 2 provides a brief summary of studies in relation the rate of return and nonlinearity regarding the schooling; Section 3 explains our empirical strategies and describes the data set from Brazil; in Section 4, the empirical findings are reported. Finally, Section 5 presents the paper’s conclusions.

2. Nonlinearity in the education

In the literature on the schooling returns, Mincer (1974), in his seminal work, estimates the wage equation in which the logarithm of hourly earnings is explained by schooling years, experience and the square of experience. In this model, the estimated coefficient of schooling is interpreted as the return of an additional year of schooling. The pioneering work of Mincer has been repeated by several authors for different countries and periods (Psacharopoulos, 1994; Psacharopoulos and Patrinos, 2004; Rauch, 1993; Blackburn and Neumark, 1993; Moretti, 2004; Pons and Gonzalo, 2001). For Brazil we have several studies as Psacharopoulos (1987), Leal and Werlang (1991), Blom et al. (2001) and Araújo and Silveira Neto (2004). These studies, although important in the literature, did not consider the sample selection bias discussed by Heckman (1979).

Heckman (1979) investigated the bias that resulted from estimations using a non-randomly selected samples to analyze behavioral relationships. For example, when observations on wage are available only for those who are working, the wage offered by employers exceeds their personal reservation wage. A two-step process is used to correct the bias. The Heckman approach has been used in some Brazilian empirical analysis, including Kassouf (1994), Sachsida et al. (2004), Resende and Wyllie (2006) and Dias et al. (2013).

In general, a linear rate of return to education is often used in such literature. However, additional empirical studies indicate the nonlinearity of the returns. Linear models assume that the returns to education are identical for each level of education, while nonlinear models allowing for different returns with different educational years.

Analyzing the return to education by country, over 60 countries, Psacharopoulos (1985) found that the returns are highest for primary education. Heckman et al. (2008) considered a nonparametric approach and nonlinear earnings for each year of schooling. They estimated the marginal internal rates of return to education using data from U.S. decennial Censuses and the Current Population Survey. It is found that the returns for graduating from high school are larger than the returns of graduating from college. Park (2011) explored the return to education in terms of respondents to the National Longitudinal Survey of Youth for U.S. who changed jobs after an intervening period of education reinvestment. A linear rate of return to education is rejected. The marginal rate of return increases in the former education level and with 15 years of the former level, the maximum, the real hourly rate of pay increases approximately 20% with an additional year of investment. In Brazil, Dias et al. (2013) estimated the rates of return by establishing the possibility of increasing returns as proposed by Acemoglu (1996) and Yamarik (2008) models. They found that increased returns to education start between four and five years of schooling and that the rate of returns for the first year decreases in the subsequent years. It is reached again only after almost concluding secondary education.

In terms of health groups, Lamichhane and Sawada (2013) estimated the rate of returns to education for individuals with disabilities in Nepal. The results indicated that the return to investment in education among persons with disabilities is between 19.3% and 25.6% higher than those without disabilities. High returns are associated with low educational level group. Lamichhane and Watanabe (2015) investigated the effect of gender on returns to education for men and women with disabilities in the Philippines. Using three methodological strategies, they found that the effects of disability for women are more severe than for men. In a developed country context, Hollenbeck and Kimmel (2001) examined the education returns for individuals with poor health or disability in U.S. As a result, they found moderate return to a year of education for both the disabled and nondisabled individuals, however it was found that the differential between returns to education for disabled and nondisabled individuals is minimal.

3. Methodology

3.1. Nonlinear model

Acemoglu (1996) discussed a microfoundation for increasing returns in human capital accumulation, emphasizing the matching effect, that is, the rate of return for other firms will also increase when a group of firms invests more, which affects the educational decisions of workers. In other words, if a group of workers increases its education, firms will invest more hoping to employ these workers, so wages will increase for all, even for some of the workers who have not invested in their human capital. Acemoglu explores a non-Walrasian approach. In contrast, Dias et al. (2013) developed a Walrasian allocation of the Acemoglu model, following the model proposed by Yamarik (2008).

The theoretical model of Dias et al. (2013) investigates the returns to scale in producing human capital from the relationship between the wage rate with years of schooling, schooling squared, schooling cubed, experience, experience squared, and other control variables.

This paper employs the Dias et al. (2013) model, with returns to scale in producing human capital but including a health variable. Accordingly, we consider that, in addition to education and experience, health also plays an important role in human capital.

It is assumed that there are n competitive firms in producing the product, y_n. The production function of firm n is

$$y_n = A_n K_n^{1-\beta} H_n^{\beta} \tag{1}$$

where A_n is technology, and K_n is the capital stock, both of which depend on qualified human capital. H_n is the level of production that is dependent on the choice of human capital. β is the elasticity of product with respect to human capital. Thus, human capital has the following specification

$$H_n = \sum_{i=1}^{L_n} h_i = \sum_{i=1}^{L_n} e^{\phi_i(S,E,Z)} = L_n e^{\phi_i(S,E,Z,O)} \tag{2}$$

L_n is the amount of human capital with qualification i (hi) hired by the company n. Thus, human capital is a function of schooling (S), experience (E), health (Z) and other characteristics of the individual (O).

However, it is not always possible for the firm to choose the level of education of individuals to hire because it cannot find available people with such human capital. The education level, i, is given, and the firm chooses only the optimal amount of this human capital, L_n. Therefore, the condition for profit maximization follows

$$w_{hi} = \beta A_n k_n^{1-\beta} e^{\beta \phi_i(S,E,Z,O)} \tag{3}$$

In the proposed model, wages (w_{hi}) depend on technology (A), the capital/labor ($k_n = K_n/L_n$) and human capital associated with the experience, schooling and health. Because A_n and k_n are given at one point in time, wage depend on the human capital of the worker i.

According to Eq. (3), rates of return are associated with education, with an expected higher rate of return to higher educational levels. Similar to education, individual health is also correlated with rates of return, so individuals with better health should have higher returns. The technology (A_n) and the capital stock per worker (k_n) influence the real wage, but have no effect on the rate of return to education.

Given a simple extension of the Mincerian equation, the authors investigated possible increased returns due to individual human capital, and, if increasing returns exist, it is possible to determine the level of schooling at which they begin (threshold effect).

Finally, adding to the equation the interaction of health with schooling, schooling squared and schooling cubed with the purpose of considering health status on the rate of return to education, we have

$$\ln(w_i') = \beta_0 + \beta_1 S_i + \beta_2 S_i^2 + \beta_3 S_i^3 + \beta_4 S_i Z + \beta_5 S_i^2 Z + \beta_6 S_i^3 Z + \beta_7' E_i + \beta_8 E_i^2 + \beta_9' O_i + \varepsilon_i \tag{4}$$

where O is a matrix of control variables. Thus, the estimated rate of return to education is

$$\frac{\partial \ln(w)}{\partial S} = \hat{\beta}_1 + 2\hat{\beta}_2 S + 3\hat{\beta}_3 S^2 + \hat{\beta}_4 Z + 2\hat{\beta}_5 SZ + 3\hat{\beta}_6 S^2 Z \tag{5}$$

The marginal rate of return is therefore

$$\frac{\partial^2 \ln(w)}{\partial S^2} = 2\hat{\beta}_2 + 6\hat{\beta}_3 S + 2\hat{\beta}_5 Z + 6\hat{\beta}_6 SZ = 0 \tag{6}$$

where $\partial^2 \ln(w)/\partial S^2 > 0$ (<0) indicates increasing (diminishing) rates of return to education. Therefore, the above theoretical model allows the estimation of gains for each school year.

The health variable (Z) assumes a value of one for healthy individuals and is zero otherwise.

3.2. Econometric model specifications

The estimated model takes the following form:

$$\begin{aligned} \text{Ln}\,(w_i) = {} & \beta_0 + \beta_1 S + \beta_2 S^2 + \beta_3 S^3 + \beta_4(\text{exp}) + \beta_5(\text{exp})^2 + \beta_6(dformaljob) + \beta_7(dfemale) \\ & + \beta_8(dmarried) + \beta_9(d2008) + \beta_{10}(dreportedhealth) + \gamma_1(race) + \gamma_2(region) + \varepsilon_i \end{aligned} \tag{7}$$

where $\ln(w_i)$ denotes the logarithm of the monthly wage per hour; S is schooling; and (*exp*) is experience. The following are dummy variables: (*dformaljob*), assumes a value of one if the worker has a formal job and is zero otherwise; (*dfemale*), assumes a value of one if woman and is zero otherwise; (*dmarried*), assumes a value of one if married and is zero otherwise; (*d2008*), assumes a value of one if year 2008 and is zero otherwise; (*dreportedhealth*), assumes a value of one if individual reported health and is zero otherwise; (*race*), four dummy variables to distinguish between white (base), black, yellow and brown; (*region*), five dummy variables to distinguish the Northeast (base), North, Midwest, Southeast and South.

To avoid a possible selection bias, which occurs because unemployed people only accept a job if the earnings are higher than their reservation wage, we used Heckman's (1979) approach. Thus, it is considered the selection equation, namely: individual works (dependent variable), schooling; married, number of family members, woman with children under age 14, *searched for work* and chronic diseases.

Table 1
Descriptive statistics.

Variable name	Obs.	Mean	Std. dev.	Min.	Max.
Log hourly wage	281 127	1.2982	0.9236	−5.971	6.397
Years of schooling	416 194	7.6079	4.4524	0	15
Experience	316 720	22.4106	12.8425	0	60
Number of family members	417 089	3.6329	1.5089	1	17
Female	418 701	0.5116	0.4999	0	1
White (default category)	418 701	0.4763	0.4994	0	1
Black	418 701	0.0771	0.2668	0	1
Brown	418 701	0.4421	0.4966	0	1
Yellow	418 701	0.0046	0.0673	0	1
Married	378 276	0.8261	0.3790	0	1
Formal job	418 701	0.3307	0.4705	0	1
Northeast (default category)	418 701	0.3020	0.4591	0	1
North	418 701	0.1127	0.3163	0	1
Midwest	418 701	0.1146	0.3186	0	1
Southeast	418 701	0.3127	0.4636	0	1
South	418 701	0.1579	0.3646	0	1
d2008	418 701	0.5152	0.4998	0	1
Health	418 684	0.7449	0.4359	0	1
Individual reported health	418 701	0.5705	0.4949	0	1
Worked in the reference week	418 681	0.6791	0.4668	0	1
Woman with child <14 years	418 701	0.0538	0.2256	0	1
Searched for work	418 681	0.1304	0.3367	0	1

3.3. Data description

The data we used are from the *National Survey by Household Sample* (PNAD) for the years 2003 and 2008, which have a special supplement on health.

Health status is measured by individual self-assessment. The individual evaluates their health as very good, good, fair, poor or very poor. In this paper, we consider good health to be very good or good health and poor health otherwise.

For the sample selection, the following filters were used: the sample includes individuals between 20 and 64 years old; individuals with an hourly wage of up to R$ 600; and the Federal District (Brasília) was excluded from the sample because its economic activity is concentrated in the public sector. Experience is calculated as the individual's age minus the age when they started working. Schooling is considered in years and ranges from 0 to 15 years, where 15 refer to 15 or more years of study. Table 1 shows the descriptive statistics of the variables used in this paper.

Fig. 1 shows the average hourly wage by years of schooling in terms of self-reported health. In brief, those who reported good health have an hourly wage that is higher than those who indicated poor health, with a marked difference especially for highly qualified people with 15 years or more of schooling.

In addition, Fig. 2 displays the concentration of individuals with poor health at lower levels of schooling, showing the positive relationship between health and education. For individuals in poor health, more than half reported having up to 4 years of schooling, while for individuals in good health, approximately 50% have at least 9 years of schooling. Undergraduates and graduates include 17% of the individuals in good health and only 6% in poor health.

4. Returns to education

The returns to education are analyzed in two ways according to Table 2. (i) The first column presents the results of Eq. (4) and includes the interaction between education and health. (ii) The second column shows the estimation of Eq. (7) for individuals in poor health, and the third column shows the estimate for individuals in good health. Both cases use Eqs. (5) and (6) to estimate the rate of return and the marginal rate.

The equations are estimated by ordinary least squares (OLS) and use the procedure of Heckman (1979) to correct the selectivity bias. The statistical test indicates that the sample selection bias, athrho, was statistically significant at 5%

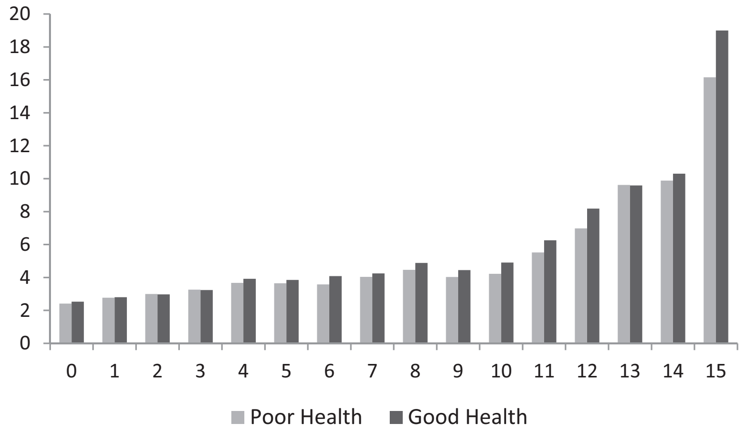


Fig. 1. Hourly wage for years of schooling in terms of self-reported health.

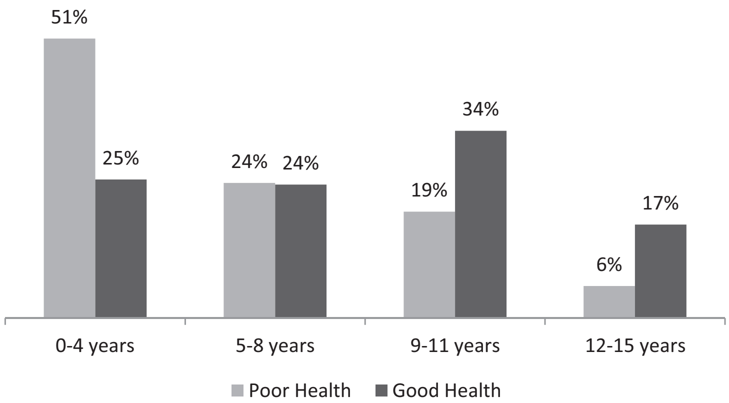


Fig. 2. Distribution of individuals by education level in terms of self-reported health.

in all models, indicating a correlation between the wage equation and the selection equation. Therefore, the Heckman method is the most appropriate for the analysis. In addition, sample weights and stratification are considered.

In order to produce unbiased estimators using OLS, the assumption of normally distributed residuals must be satisfied. Formal tests of normality of the residuals can be performed. However, it is crucial to graph a standardized normal probability plot for estimates using large samples size, since the normality test might conclude that a small deviation from normality is significant. In all graphs, for column (1), (2) and (3), it was found a mild deviation, which is not enough to conclude the non-normality of residuals. The graphs are shown in Appendix I.

In all estimates, the coefficient of the formal job indicated that, considering the effects of other variables, the wage of individuals with a formal job was superior to that of all other individuals, especially among groups who reported poor health. Females indicated wages approximately 24% less than men in all groups, while married people had wages approximately 10.6% higher than unmarried people. For race, blacks and browns had the lowest wages, approximately 14% lower than whites (omitted), while yellow presented wages of 15% higher than whites. All regions showed a wage higher than those in the Northeast (omitted). The Southeast region, which had better wages, reported an hourly wage approximately 45% higher than that in the Northeast. Moreover, based on the interaction (*HealthXSchooling*), a positive effect of schooling on health was observed.

The results of the selection equation are reported on the bottom of Table 2. Schooling and married people indicated a positive effect on reservation wage. Number of family members showed a negative effect on reservation wage. The

Table 2
Estimated log of hourly wage with interaction and separate equations for health.

Log hourly wage	Health interaction		Poor health		Good health	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
Schooling	0.0991***	(0.00538)	0.124***	(0.0062)	0.131***	(0.00464)
Schooling squared	−0.0103***	(0.00095)	−0.0139***	(0.00101)	−0.0147***	(0.000634)
Schooling cubed	0.0007***	(0.0005)	0.0009***	(0.0004)	0.000943***	(2.69e−05)
Experience	0.0309***	(0.00049)	0.0235***	(0.00111)	0.0316***	(0.0006)
Experience squared	−0.0004***	(0.00009)	−0.0003***	(0.0002)	−0.0004***	(0.0002)
Formal job	0.138***	(0.00446)	0.260***	(0.0077)	0.108***	(0.0047)
Female	−0.264***	(0.00396)	−0.252***	(0.0083)	−0.269***	(0.0042)
Married	0.0890***	(0.00457)	0.0748***	(0.0107)	0.0966***	(0.0051)
d2008	0.137***	(0.00657)	0.160***	(0.0103)	0.131***	(0.0066)
Individual reported health	0.0214***	(0.00356)	−0.0002	(0.0075)	0.0268***	(0.0039)
HealthXSchooling	0.0424***	(0.00454)				
Health x Schooling squared	−0.0059***	(0.00093)				
Health x Schooling cubed	0.0003***	(0.00004)				
Black	−0.146***	(0.00694)	−0.140***	(0.0140)	−0.147***	(0.0075)
Yellow	0.139***	(0.0321)	0.123**	(0.0515)	0.141***	(0.0364)
Brown	−0.153***	(0.00457)	−0.138***	(0.0084)	−0.156***	(0.0049)
Midwest	0.340***	(0.0112)	0.336***	(0.0154)	0.338***	(0.0121)
North	0.295***	(0.0109)	0.320***	(0.0149)	0.287***	(0.0117)
Southeast	0.372***	(0.00871)	0.363***	(0.0124)	0.371***	(0.0092)
South	0.336***	(0.0100)	0.347***	(0.0151)	0.329***	(0.0106)
Constant	−0.0937***	(0.0177)	−0.216***	(0.0366)	−0.0496***	(0.0185)
Observations	363,526		92,793		270,733	
Worked in the ref. week						
Schooling	0.0368***	(0.000693)	0.0411***	(0.0012)	0.0290***	(0.0008)
Married	0.125***	(0.00826)	0.203***	(0.0140)	0.0842***	(0.0099)
N. family members	−0.0118***	(0.00186)	0.0146***	(0.0032)	−0.0229***	(0.0022)
Woman with child <14	0.0634***	(0.0128)	0.215***	(0.0238)	−0.0066	(0.0147)
Searched for work	−0.594***	(0.00910)	−0.191***	(0.0180)	−0.711***	(0.0097)
Column	−0.0316***	(0.00695)	0.0397***	(0.0106)	−0.0169*	(0.0092)
Rheumatism	−0.248***	(0.0107)	−0.173***	(0.0137)	−0.248***	(0.0165)
Cancer	−0.500***	(0.0366)	−0.505***	(0.0448)	−0.339***	(0.0613)
Diabetes	−0.238***	(0.0145)	−0.203***	(0.0174)	−0.180***	(0.0251)
Bronchitis	−0.0704***	(0.0135)	−0.0391**	(0.0190)	−0.0435**	(0.0183)
Hypertension	−0.223***	(0.00768)	−0.155***	(0.0109)	−0.203***	(0.0104)
Heart failure	−0.239***	(0.0137)	−0.205***	(0.0159)	−0.165***	(0.0246)
Renal insufficiency	0.0423**	(0.0191)	0.0685***	(0.0226)	0.0998***	(0.0325)
Depression	−0.399***	(0.0111)	−0.380***	(0.0143)	−0.305***	(0.0179)
Tuberculosis	−0.136**	(0.0585)	−0.245***	(0.0745)	0.0819	(0.0916)
Cirrhosis	−0.0754	(0.0670)	−0.0997	(0.0764)	0.118	(0.119)
Tendinitis	0.00382	(0.0142)	0.00729	(0.0214)	0.0080	(0.0191)
Constant	0.309***	(0.0117)	−0.128***	(0.0201)	0.502***	(0.0141)
Athrho	−0.226***	(0.0135)	0.0968**	(0.0454)	−0.321***	(0.0133)
Ln sigma	−0.352***	(0.00418)	−0.303***	(0.0071)	−0.359***	(0.0048)

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

variables for chronic diseases were also found negative. These variables indicate that prevalence of chronic diseases are expected to negatively affect individual's decision to engage in paid work.

Tables 3 and 4 summarize the rate of return to education and the marginal rate. Years of schooling are presented at the end of the educational stages in addition to average schooling. @ represents the years of schooling that mark the start of increasing returns to schooling.

Table 3
Return to education for good health and poor health – interaction.

Years of schooling	Good health		Years of schooling	Poor health		Δ%
	$(\partial \ln(w))/\partial S$	$(\partial^2 \ln(w))/\partial S^2$		$(\partial \ln(w))/\partial S$	$(\partial^2 \ln(w))/\partial S^2$	
0	0.142	−0.032	0	0.099	−0.021	−30.3%
4	0.060	−0.008	4	0.052	−0.003	−13.3%
8	0.074	0.016	8	0.074	0.014	0%
11	0.148	0.034	11	0.138	0.028	−6.7%
15	0.331	0.058	15	0.283	0.045	−14.5%
7,6	0.069	0.013	7,6	0.069	0.013	
	@ 5.396			@ 4.701		

Table 4
Return to education for people with good health and poor health – separate equations.

Years of Schooling	Good health		Years of schooling	Poor health		Δ%
	$(\partial \ln(w))/\partial S$	$(\partial^2 \ln(w))/\partial S^2$		$(\partial \ln(w))/\partial S$	$(\partial^2 \ln(w))/\partial S^2$	
0	0.131	−0.029	0	0.124	−0.028	−5.3%
4	0.058	−0.007	4	0.055	−0.007	−5.2%
8	0.078	0.016	8	0.070	0.014	−10.3%
11	0.152	0.033	11	0.136	0.030	−10.5%
15	0.330	0.056	15	0.297	0.051	−10.0%
8,2	0.080	0.017	5,7	0.051	0.002	
	@ 5.188			@ 5.299		

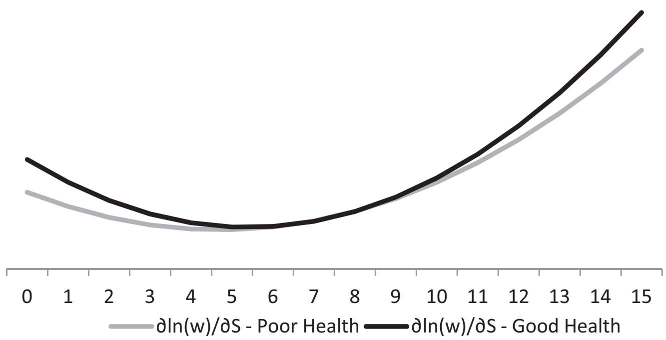


Fig. 3. Return to education in terms of health – interaction.

First, the rate of return is analyzed with interaction between education and health, Table 3.[1] The return to education is higher for individuals in good health for almost all of the 15 years of schooling in comparison to those in poor health. For people with 7 and 8 years of schooling, the rate of return was found to be equal independent of health status. Increasing rate of return to education starts from 4.7 years of schooling for those in poor health and 5.4 years of schooling for those in good health.[2]

Fig. 3 illustrates the rate of return over 15 years of schooling, as well as for poor health and good health. The differential in the rate of return is higher at the ends. The rate of return for an individual without education is 30.3% lower for those in poor health. For those with 15 or more years of schooling, the rate of return is 14.5% lower than those with good health.

[1] Column (1) of Table 2.
[2] As cited above, Dias et al. (2013) found that increased returns to education start between four and five years of schooling in Brazil.

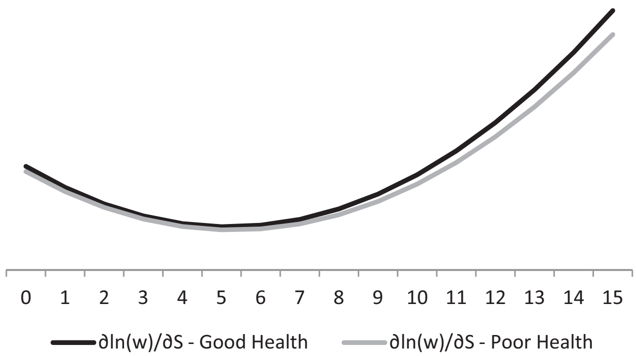


Fig. 4. Return to education in terms of health – separate.

Next it is reported estimates for separate equations (good and poor health), Table 4.[3] The Hausman test (1978) is performed to confirm whether there are differences between the coefficients. Estimates of the same equation but for group health show there are differences in the rate of return for all years of schooling and that this differential increases with qualifications (Table 4).

The return to education is 10% lower for those in poor health compared to those in good health starting in eighth grade. Increasing returns, @, start with 5.3 years of schooling for those with poor health and 5.2 years of schooling for those with good health. Fig. 4 shows the difference in the rate of return for 15 years of schooling.

The Hausman test allows us to determine whether the estimated coefficients for good and poor health in Table 4 are significantly different or not. The null hypothesis is that the differences in coefficients are not systematic. The test showed that the null hypothesis was rejected, indicating that the differences are systematic; that is, there are differences in the rate of return to education between individuals in poor and good health (Appendix II).

The average schooling of the two groups is noteworthy; individuals with health problems have on average 5.6 years of schooling, while individuals without health problems have a much higher average schooling, 8.3 years. This result has been found in several studies. The relationship between health and education is well established in the literature, as argued by Eide and Showalter (2011).

Therefore, although individuals in good health present higher educational levels, the results suggest that, when healthy and unhealthy people have the same level of education, they are not remunerated equally, causing a differential in the rate of return to education. In other words, lower returns to education are obtained by individuals in poor health.

In specific for people with 15 or more years of schooling, wherein the rate of return is 10–14.5% lower for those who are unhealthy, some characteristics of the groups are highlighted as potential explanations of this differential. The group who reported poor health is older and has more women, mean age of 45 years and 61% are women, while the mean age of the group who reported good health is 39 years and 56% are women. Another important difference between the groups refers to the sector to which they belong. There is a higher proportion of individuals with poor health working in the educational sector (33%) and lower proportion in the health sector (7%), compared to individuals with good health, 24% and 12%.

Furthermore, in both analyzes, seven and eight years of schooling is an interesting point. In Brazil, eight years of schooling is equivalent to full primary education. Barbosa Filho and Pessôa (2008) found similar result by calculating the rate of return to education in Brazil using the Internal Rate of Return (IRR) to education. The results indicated high rates of return to education. They found 15.9% for 0–4 years of schooling, 13.7% for 4–8 years of schooling and 19.1% for 8–11 years of education. Therefore, lower return in the last years of primary school.

5. Conclusion

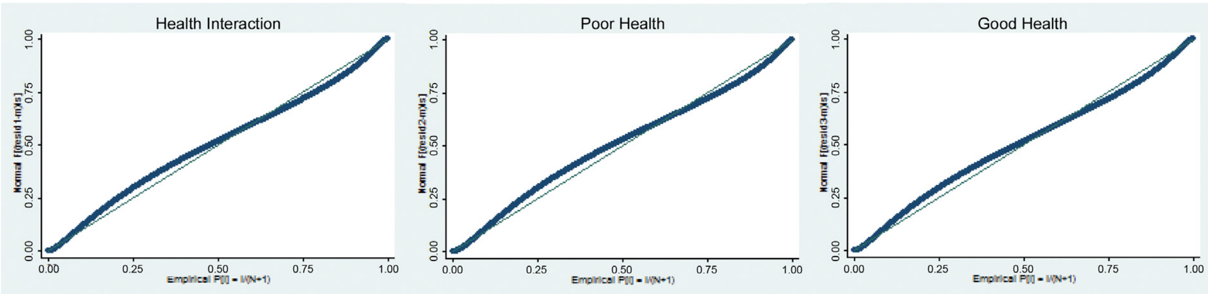
In Brazil, twenty-five percent of people reported being in poor health, making a large population subject to the well-established limitations described in the literature. There is strong evidence that health plays a central role in education and income; however, we also analyzed the rate of education considering health status.

[3] Column (2) and (3) of Table 2.

Our results indicate that, in general, the rate of return decreased until four and five years of schooling, that is, until primary education was completed, at which point increasing returns began. After this point, the returns reach a maximum with 15 years of schooling. The estimation result also shows that the rate of return to education is lower for individuals in poor health; for individuals with 15 or more years of schooling, the rate of return is 10–14.5% lower for those who are unhealthy, which may discourage schooling by this group of individuals.

Another point is the different characteristics found between healthy and unhealthy. The average amount of schooling is 8.2 years for those in good health and 5.7 years for those in poor health. Specifically for people with 15 or more years of schooling, the group who reported poor health is older and has more women. Finally, our results suggest the importance of programs targeted to individual health, or in the other ways improve their health levels, given its relationship to key variables throughout the individual's life, such as education and return.

Appendix I. Standardized normal probability



Appendix II. Hausman Test

	Poor Health (b)	Good Health (B)	Difference (b − B)	Sqrt (diag (V_b − V_B))
Schooling	0.12398	0.13072	−0.00673	0.003996
Schooling squared	−0.01388	−0.01468	0.00079	0.000789
Schooling cubed	0.00087	0.00094	−0.00007	0.00004
Experience	0.02350	0.03164	−0.00814	0.000959
Experience squared	−0.00025	−0.00036	0.00011	0.000016
Formal job	0.25986	0.10772	0.15213	0.006097
Midwest	0.33643	0.33767	−0.00125	0.00959
North	0.31977	0.28702	0.03275	0.009298
Southeast	0.36306	0.37093	−0.00787	0.00833
South	0.34655	0.32878	0.01777	0.010721
Female	−0.25189	−0.26877	0.01688	0.007177
Married	0.07482	0.09661	−0.02179	0.00938
Black	−0.14019	−0.14688	0.00669	0.011849
Yellow	0.12287	0.14057	−0.01771	0.036453
Brown	−0.13756	−0.15572	0.01816	0.006866
d2008	0.16036	0.13148	0.02888	0.007986
Individual reported health	−0.00016	0.02678	−0.02694	0.006441
		Chi^2(15) = 1022.90		
		Prob > chi^2 = 0.0000		

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